PRISM ENGINEERING

June 15, 2004

Dan Landon
Executive Director
NCTC
101 Providence Mine Road
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Nevada City, CA 95959

RE: Saturation Flow Rates for Brunswick Basin

Dear Dan:

As requested, I gathered data in the Brunswick Basin area to measure saturation flow rates along Brunswick Road as well as the SR 20/49 EB Off-ramp traffic. Table 1 summarizes the specific saturation flow rate measurements for many signal cycles. The Highway Capacity Manual (HCM) details how this is to be done in Chapter 16 pages 158-160, which states that measurements are taken cycle by cycle, and that the time between the fourth vehicle crossing the stop bar after the light turns green and the last vehicle in the queue, is the time to measure. This time is then divided by the number of vehicles that crossed the line from the beginning to end time. This value is the average headway (in seconds) between each vehicle in the queue.

The HCM then states that the saturation flow rate is 3,600 vehicles per hour divided by the average headway. For example, if the average headway is 2.0 seconds, then the saturation flow rate is 3,600 / 2.0 = 1,800 vehicles per hour. The HCM then states that a minimum of 15 signal cycles with more than 8 vehicles in the initial queue is typically required. Our survey included 21 samples as shown in Table 1. Traffic was not busy all of the peak hour time period. There were times when traffic was scarce and not at capacity. For this reason, it was not possible to gather saturation flow rates for the entire period or for every signal cycle. It was necessary to wait until there were at least 8 vehicles in a queue behind the stop bar just before the signal turned green in order to get a statistically significant value.

Table 1
Saturation Flow Rate Samples on Brunswick Road

	Brunswick NB Approach at SR 20/49 Off-ramp						SR 20/49 NB Off-ramp at Brunswick						Brunswick SB Approach at Sutton Way			
Time of Day	Seconds to Clear Queue	Total Cars in Initial Queue	Free Flow Cars in Queue*	Avg. Headway (seconds)	Saturation Flow Rate**		Seconds to Clear Queue	Total Cars in Initial Queue	Free Flow Cars in Queue*	Avg. Headway (seconds)	Saturation Flow Rate**		Seconds to Clear Queue	Total Cars in Initial Queue	Free Flow Cars in Queue*	Avg. Headway (seconds)
4:00 PM																
4:02 PM																
4:03 PM	4.70	10	6	0.78	4596											
4:05 PM																
4:07 PM																
4:09 PM																
4:11 PM	21.54	16	12	1.80	2006											
4:13 PM																
4:15 PM	25.29	17	13	1.95	1851											
4:16 PM																
4:18 PM	9.75	9	5	1.95	1846											
4:19 PM	16.13	13	9	1.79	2009		7.53	8	4	1.88	1912					
4:21 PM	11.71	10	6	1.95	1845											
4:22 PM	13.79	12	8	1.72	2088											
4:24 PM																
4:26 PM							11.34	9	5	2.27	1587					
4:28 PM	7.82	9	5	1.56	2302											
5:04 PM	20.40	15	11	1.85	1941		12.97	10	6	2.16	1665					
5:06 PM	26.90	18	14	1.92	1874											
5:08 PM							10.70	9	5	2.14	1682		14.95	13	9	1.66
5:10 PM																
5:12 PM																
5:14 PM							12.35	10	6	2.06	1749					
5:16 PM	8.37	8	4	2.09	1720											
5:18 PM																
5:20 PM	12.56	10	6	2.09	1720	(onramp)										
5:22 PM	20.45	15	11	1.86	1936											
5:24 PM													10.81	9	5	2.16
5:26 PM													15.32	12	8	1.92
5:28 PM																
5:29 PM																
Averages	199.41	162	110	**1.81**	**1986**	**avg flow**	54.89	46	26	**2.11**	**1705**	**avg flo**	41.08	34	22	**1.87**
Total Average			295.38	158	**1.87**	**1926**	**= avg overall flow rate**									

*Freeflow cars are measured after the fourth car crosses the stop bar line.
**Saturation Flow Rate is calculated by the following formula: 3600/(avg headway).

Table 1 shows three different groups of surveys, one for Brunswick Road northbound at the SR 20/49 Off-ramp intersection, one for the SR 20/49 Off-ramp at the Brunswick Road intersection, and one for Brunswick Road southbound at the Sutton Way intersection. The average saturation flow rate for Brunswick Road northbound was 1,986 vehicles per hour ranging from 1,720 to 4,596 vehicle per hour. The overall average for the area was 1,926 vehicles per hour for saturation flow rate measurements.

Our analyses of the Brunswick Road intersections with Synchro Pro and Sim Traffic utilized a saturation flow rate of 1,900 vehicles per hour, which is more conservative than the actual measured flow rates in the field. In fact, if the peak hour traffic was truly at saturation (full capacity), it is anticipated that the saturation flow rate would be significantly higher.

Conclusion

Our analysis examining the traffic operations of Brunswick Road with the proposed changes/mitigations defined in the Brunswick Corridor Study and other recent traffic studies, such as the DuPell Commercial Project, etc., is valid given the saturation flow rate compatibility as validated with field measurements. These are the same simulations shared in our last NCTC TAC Meeting. Also, our lane utilization closely replicates what is taking place in the field. We have also taken video footage to show this information.

Sincerely,
PRISM Engineering

Grant P. Johnson, PE, PTOE
Principal